OSMORHIZA BIPATRIATA (APIACEAE) IN TEXAS: TAXONOMIC STATUS AND CONSERVATION CONSIDERATIONS

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ABSTRACT

The paper evaluates the taxonomic and conservation status of *Osmorhiza bipatriata* Constance & R.H. Shan. The available phylogenetic data support its recognition as a distinct species. It has a highly restricted distribution on Mt. Livermore of the Trans-Pecos region in Texas, as well as in Coahuila and Nuevo León, Mexico. Its habitat on Mt. Livermore is highly restricted within the mesic *Pinus strobiformis* community, where it is associated with several other taxa that are also rare in Texas, such as *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry and *Aquilegia longissima* A. Gray. The population of *O. bipatriata* on Mt. Livermore is small (< 20 individuals), although apparently healthy, with a full range of age structure. Application of the IUCN Red List criteria shows that *O. bipatriata* is an endangered species [B2ab(iv)]. We recommend careful monitoring of *O. bipatriata* and its associated habitat, and restricted access to its only known locality within the United States.

RESUMEN

En este artículo se evalúa el estatus taxonómico y de conservación de *Osmorhiza bipatriata* Constance & R.H. Shan. Los datos filogenéticos disponibles apoyan su reconocimiento como una especie independiente. Tiene una distribución muy restringida en el Mt. Livermore de la región Trans-Pecos en Texas, así como en Coahuila y Nuevo León, México. Su hábitat en el Mt. Livermore está muy restringido dentro de la comunidad mésica de *Pinus strobiformis*, donde está asociado con otros varios taxa que también son raros en Texas, tales como *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry y *Aquilegia longissima* A. Gray. La población de *O. bipatriata* en el Mt. Livermore es pequeña (< 20 individuos), aunque aparentemente saludable, con una estructura de edad con el rango completo. La aplicación de los criterios IUCN para la Lista Roja muestran que *O. bipatriata* es una especie amenazada [B2ab(iv)]. Recomendamos un control cuidadoso de *O. bipatriata* y su hábitat asociado, y acceso restringido a su única localidad conocida en los Estados Unidos.

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INTRODUCTION

Osmorhiza Raf. (Apiaceae subfam. Apioideae) is a small genus of approximately 11 species, including nine that occur in North America (two of which are also disjunct in South America) and one each in Asia and the central Andes. Members of the genus are characterized by their deep brown to black, linear to oblong, fusiform to clavate fruits that are slightly compressed laterally and have a caudate basal appendage and filiform ribs, which in most species bear numerous retrorse bristles (Lowry & Jones 1984). Several recent molecular phylogenetic analyses have shown that *Osmorhiza* is monophyletic and that it is most closely related to the Old World genera *Myrrhis* Mill. and *Geocaryum* Coss. (Downie et al. 2000; Wen et al. 2002; Yoo et al. 2002). These studies have also indicated that all the New World members of *Osmorhiza* evolved from a common ancestor that arrived from Asia, where the genus appears to have originated (Wen et al. 2002). Within the New World clade, a group of largely western North American species forms a well supported subclade that probably diversified relatively rapidly. Two of these species, *O. berteroi* DC. and *O. depauperata* Phil., have subsequently dispersed into the Great Lakes area, eastern North America, and southern South America, and another, *O. mexicana* Griseb., has an interrupted range from northern Mexico to northern Argentina, while the remaining species occupy relatively narrow geographic ranges in the western United States (Lowry & Jones 1984; Wen et al. 2002).

Specimens attributed to one of these species, *Osmorhiza bipatriata* Constance & R.H. Shan, were first collected on September 28, 1935, by L.C. Hinckley on Mt. Livermore in the Davis Mountains of the Trans-Pecos region in Texas (*Hinckley 408*, SRSC). Constance & Shan (1948) described this sweet cicely (herein referred to as the bipatriate sweet cicely) from the Davis Mountains and northern Mexico as a species new to science based on a later collection by Hinckley (26 Jul 1937, *L.C. Hinckley s.n.*; holotype at NY and isotypes at ARIZ and GH). Constance & Shan chose the epithet to reflect the presence of *O. bipatriata* in two countries as well as the two nationalities of its authors. Lowry & Jones (1984) reported several morphological intermediates between *O. bipatriata* and *O. mexicana* collected from sites in northern Mexico, including on Cerro Potosí in Nuevo León, where the two taxa occur sympatrically. These intermediates prompted them to reduce *O. bipatriata* to a subspecies of *O. mexicana*. Recently, Turner et al. (2003) recognized the taxon as a variety of *O. mexicana* because he chose, somewhat arbitrarily, not to use the rank of subspecies in his work (B.L. Turner, pers. comm.).

TAXONOMIC STATUS

Phylogenetic analyses conducted in the last several years using sequence data from the nuclear ribosomal ITS regions and the chloroplast *ndh*F gene and *trn*L-

F regions (Downie et al. 2000; Wen et al. 2002; Yoo et al. 2002) suggest that *Osmorhiza mexicana* and *O. bipatriata* do not form a monophyletic group and indicate that they show considerable divergence in their sequence profiles of these markers (e.g., 1.415% divergence between the ITS sequences). In the ITS phylogeny, the positions of the two taxa are unresolved, although both are closely related to other western North American members of *Osmorhiza* (Downie et al. 2000; Wen et al. 2002). The chloroplast data set suggests that *O. bipatriata* is most closely allied to *O. depauperata* (Yoo et al. 2002). The available data thus do not support the inclusion of *O. bipatriata* within *O. mexicana* at an infraspecific level. The phylogenetic data suggest instead that it should be treated as a distinct species, as initially proposed by Constance & Shan (1948), using either the phylogenetic (Nixon & Wheeler 1990) or the lineage (de Queiroz 2000) species concept. While the presence of morphological intermediates in northern Mexico would appear to be incompatible with the recognition of *O. bipatriata* using the classical morphological species concept, as supported by Cronquist (1978), the phylogenetic data suggest that these intermediates may represent interspecific hybrids or perhaps may have resulted form introgression between *O. bipatriata* and *O. mexicana*. Detailed analyses, however, will be required to assess the origin of these intermediates.

Osmorhiza bipatriata differs from its congeners by its small (9–11 mm long) and glabrous fruits, which are linear-fusiform and taper into a short beak at the apex, and by its very short styles [0.5–0.75 mm long (Lowry & Jones 1984)]. Based primarily on fruit morphology, Constance & Shan (1948) placed *O. bipatriata* in subgen. *Glycosma*, but commented that it possessed characters intermediate with members of the typical subgenus, in particular with regard to its involucel, styles and stylopodium, which are similar to those of *O. mexicana*, which belongs to sect. *Mexicanae* of subgen. *Osmorhiza* (see Constance & Shan 1948; Lowry & Jones 1984). Our molecular phylogenetic studies (Wen et al. 2002; Yoo et al. 2002) show that *O. bipatriata* possesses a large number of unique molecular nucleotide substitutions, suggesting its antiquity. *Osmorhiza bipatriata* is thus perhaps best described as a relict species, which has survived in mesic habitats in the northeastern Chihuahuan Desert, which have undergone a gradual drying since the late Tertiary (Graham 1993).

An illustration of *Osmorhiza bipatriata* is found in Lundell & collaborators (1961: plate 42). Lowry & Jones (1984) provided comprehensive information on its morphology and distribution and cited specimens from both Texas and Mexico deposited in various herbaria. Below are some additional specimens from Texas that we have examined, but which were not seen by Lowry & Jones (1984).

U.S.A. Texas. Jeff Davis Co.: Madera Canyon, Mt. Livermore, 28 Sep 1935, in fr., *Hinckley 408* (SRSC); in wet soil of spring in Madera Canyon, Mt. Livermore, 23 Jul 1945, in young fr., *Hinckley 3489* (SRSC); at the upper spring of Madera Canyon, NW slope of Mt. Livermore, 7300 ft, 12 Sep 1947, in fr., *Warnock & Hinckley 4147* (SRSC); rare at upper spring in Madera Canyon on Mt. Livermore, Davis Mountains,

igneous soil, 7500 ft, 11 Sep 1947, in fr., *Warnock & Hinckley 7479* (SRSC); infrequent in igneous soil on upper Madera Canyon of Mt. Livermore, 7500 ft, 23 Aug 1968, *Warnock 23015* (SRSC); upper Madera Canyon, Tobe Spring, NW of Mt. Livermore, just above a large horseshoe wall, in deep mesic canyon under *Pinus strobiformis – Quercus gambelii – Juniperus deppeana* forest, associated with *Rhamnus betulifolia, Symphoricarpos oreophilus, Aquilegia longissima, Polemonium pauciflorum* subsp. *hinckleyi, Salvia arizonica, Geranium caespitosa, Vitis arizonica, Ptelea trifoliata, Galium* sp., and *Thalictrum* sp., N30°38.364', W104°10.746', 7242 ft., 23 Aug 2003, in fl & fr, *Wen et al. 7265* (F).

CONSERVATION CONSIDERATIONS

Osmorhiza bipatriata has a highly restricted distribution, with only a few localities recorded on Mt. Livermore, Texas, and in Coahuila and Nuevo León, Mexico. Until recently, all of the collections from Texas were made by L.C. Hinckley and Barton Warnock (perhaps from the same locality), the most recent of which dates from 1968 (*Warnock 23015*, SRSC). During a recent study trip, we were able to relocate *O. bipatriata* on the northwestern slope of Mt. Livermore. A single, small population was found on 23 August 2003, comprising about 15 individuals, including 5–6 young seedlings. It occupied a small microhabitat with moist, rich soil in a deep mesic canyon under *Pinus strobiformis–Quercus gambelii–Juniperus deppeana* forest that differs considerably from most of the surrounding vegetation, which is primarily dominated by ponderosa pines and various oak species. The plants of *O. bipatriata* on Mt. Livermore were highly heterogeneous phenologically, with some individuals observed in flower, some in young fruit, and others in mature fruit, in addition to a few that were just emerging from the ground after a recent rain shower, which suggests that *O. bipatriata* is particularly sensitive to water availability.

Suitable habitat for *Osmorhiza bipatriata* is apparently rare in the Davis Mountains. Although the population we studied appears to be healthy, as indicated by the presence of a full age structure, from young seedlings to mature adult plants, it is small (less than 20 individuals) and only persists in a restricted microhabitat. Despite three days searching the mountain for comparable habitat, we were unable to locate any other populations. We thus recommend careful monitoring of the only known population in the United States, which may require controlled access to ensure its continued survival. *Osmorhiza bipatriata* also occurs sympatrically with two other rare taxa in the Davis Mountains: *Polemonium pauciflorum* S. Watson subsp. *hinckleyi* (Standl.) Wherry; and *Aquilegia longissima* A. Gray. We also observed two additional rare species (*Quercus depressipes* Trel. and *Aralia bicrenata* Wooton & Standl.) at a higher elevation on the same slope of Mt. Livermore, the summit of the Davis Mountains.

Osmorhiza bipatriata is not currently listed in the Texas Threatened and Endangered Species list (Texas Parks & Wildlife Department 2003) nor in the Threatened and Endangered Species System [TESS (U.S. Fish and Wildlife Service, 2003, *http://endangered.fws.gov*)]. Application of the IUCN Red List criteria (IUCN, 2001; see also *http://www.iucn.org/themes/ssc/redlists/*

RLcats 2001booklet.html) shows, however, that *O. bipatriata* is an endangered species [B2ab(iv)] because it has an area of occupancy estimated to be less than 500 km^2 and because it is both known from fewer than five localities (cf. Lowry & Jones 1984: fig. 17) and appears to have a declining number of subpopulations, as indicated by our observations on Mt. Livermore.

Most species of *Osmorhiza* have a relatively wide distribution (cf. Lowry & Jones 1984). Along with *O. glabrata* Phil., a central Andean endemic, and *O. brachypoda* Torr., found only in California and Arizona, *O. bipatriata* has one of the most restricted ranges in the genus. In the case of *O. bipatriata*, this may at least in part reflect the fact that its fruits lack the caudate appendages and retrorse bristles characteristic of most members of the genus, which are presumed to play a role in dispersal (Constance & Shan 1948; Lowry & Jones 1984), as suggested for the widespread *O. berteroi*, which Cruden (1966) concluded was bird dispersed.

In conclusion, *Osmorhiza bipatriata* is a distinct species with a long evolutionary history. It appears to be among the rarest plant species in the United States, with a single known population of less than 20 individuals occurring in a rare habitat in the Davis Mountains of west Texas. Careful studies need to be conducted to investigate its reproductive biology, seed germination and dispersal biology, ecological preferences, and conservation genetics to develop a suitable management plan for this relict species. Comparative analyses of its congeners with both widespread and restricted distributions should also provide insights into the biology of *O. bipatriata* that may be useful for its conservation. Furthermore, it is necessary to compare the Texas population with those in Coahuila and Nuevo León, Mexico in order to verify that they are indeed conspecific, as suggested by their morphology. The evolutionary consequence or impact of the possible hybridization and introgression between *Osmorhiza bipatriata* and *O. mexicana* also needs to be assessed.

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